wherein in said optical scale the scale slits of said first and second regions are comprised of grooves of V-shaped cross section and wherein the V-shaped grooves of the scale slits in said second region comprises slopes of N types of angles in one period and each slope has a width of P/2N, where P is a pitch of the periodic structure of the scale slits and N a natural number.

REMARKS

This application has been reviewed in light of the Office Action dated October 17, 2001. Claims 1-5, 13-30, and 33-35 remain under consideration in this application. Claims 16, 18, 34 have been amended to define still more clearly what Applicants regard as their invention, in terms that distinguish over the art of record. Of the claims under consideration, Claims 1, 13, 16, 18, 30, and 33-35 are in independent form. Favorable reconsideration is requested.

Initially, the Examiner notes that he has received and considered one Information Disclosure Statement that he believes has been filed in this application, but not the other. A review of our file, however, reveals only the filing of one such paper, the Information Disclosure Statement dated August 7, 2000.

The Office Action states that election is required to one of the following species:

I. Claims 1-5, 13-30, and 33-35, drawn to the specifics of the device of an optical encoder with grooves and driving in view of Igaki system comprising the first, second, sixth, tenth, twelfth, and thirteenth embodiment, which corresponds to Figures 9-13B, 14-16, 23A-25B, 32, 34, and 35.

II. Claims 6-9 and 31, drawn to the specifics of the device of an optical

The Office Action states that election is required to one of the following species:

I. Claims 1-5, 13-30, and 33-35, drawn to the specifics of the device of an optical encoder with grooves and driving in view of Igaki system comprising the first, second, sixth, tenth, twelfth, and thirteenth embodiment, which corresponds to Figures 9-13B, 14-16, 23A-25B, 32, 34, and 35.

II. Claims 6-9 and 31, drawn to the specifics of the device of an optical encoder with a specific number of slits and driving system comprising a third embodiment, which corresponds to Figures 17-19B.

III. Claims 10-12 and 32, drawn to the specifics of the device of an optical encoder with a particular surface and driving system comprising a fourth embodiment, which corresponds to Figures 20A and 20B.

In response to this election of species requirement, Applicants elect, with traverse as to the generic nature of several claims as set forth below, to prosecute Claims 1-5, 13-30, and 33-35 of Group I.

Applicants respectfully submit that independent Claim 18 (listed as reading on Species I) is generic to both independent Claim 6 (Species II) and independent Claim 10 (Species III). Although, independent Claim 18 recites "slits" while other independent claims in Group I recite "V-shaped grooves", Applicant submits that in the technical context of the invention, "V-shaped grooves" should be understood as acting as a kind of "slit"; that is, as an element that contributes to the formation of a diffraction pattern. Additionally, Group III not only involves the

objections in paragraph 1 of the Office Action, as well as the objections raised in paragraphs 2 and 3.

Claims 16 and 34 were rejected under 35 U.S.C. § 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which the Applicant regards as the invention for the phrase "slits in said second region comprises slopes of N types of angles in a number of P/N in one period where P is a pitch of the periodic structure of the scale slits and N a nature number."

Applicants have carefully reviewed and amended Claims 16 and 34 as deemed necessary to ensure that they conform fully to the requirements of Section 112, second paragraph, with special attention to the points raised in paragraph 4 of the Office Action. As shown in Figure 23B, there are types of angles θ1 and θ2 and therefore N=2 in the embodiment. By changing the ratio of the number of grooves between the first region and the second region, the number of grooves in the second region in one period can be increased so that the value N can be increased. As a result, N kinds of angles can be set in the second region. It is believed that the rejection under Section 112, second paragraph, has been obviated, and its withdrawal is therefore respectfully requested.

Claim 19 was rejected under 35 U.S.C. § 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which the Applicant regards as the invention for wavefront division by a difference between reflecting directions by said second region.

Applicants have carefully reviewed and amended Claims 18, which Claim 19 is dependent upon, as deemed necessary to ensure that Claim 19 conforms fully to the requirements of Section 112, second paragraph, with special attention to the points raised in paragraph 5 of the Office

Action. Independent Claim 18 corresponds to the embodiment shown in Figure 26 and Claim 19 corresponds to the embodiments shown in Figures 28 and 29 in which the second region is adapted to reflect the light beam into a plurality of directions. It is believed that the rejection under Section 112, second paragraph, has been obviated, and its withdrawal is therefore respectfully requested.

Claims 1, 4, 5, 13-22, 26-30, and 33-35 were rejected under 35 U.S.C. § 103(a) as being unpatentable over Japanese Patent No. JP 11-23324 (Igaki et al.), in view of U.S. Patent No. 5,124,548 (Igaki). Claims 2 and 3 were rejected under 35 U.S.C. § 103(a) as being unpatentable over Japanese Patent No. JP 11-23324 (Igaki et al.), in view of U.S. Patent No. 5,124,548 (Igaki) as applied to Claim 1, and in further view of U.S. Patent No. 5,483,059 (Igaki et al.). Claims 23-25 were rejected under 35 U.S.C. § 103(a) as being unpatentable over Japanese Patent No. JP 11-23324 (Igaki et al.), in view of U.S. Patent No. 5,124,548 (Igaki) as applied to Claim 18 aboe, and in further view of U.S. Patent No. 4,746,792 (Dil).

Applicants submit that the independent claims, together with the remaining claims dependent thereon, are patentably distinct from the cited prior art for at least the following reasons.

The aspect of the present invention set forth in Claim 1 is to an optical encoder including a light irradiating system, an optical scale having a grating for transmitting or reflecting incident light, light-receiving elements disposed in a plurality of different directions, and an optical system constructed so as to amplitude-modulate light traveling from the light irradiating system to the optical scale and transmitted or reflected by the grating, by a dividing element in which a plurality of V-shaped grooves are juxtaposed, and so as to divide the amplitude-modulated light into beams along a plurality of different directions to guide the beams to the respective light-receiving elements, wherein the dividing

element is comprised of repetitions of such structure that a plurality of V-shaped grooves consisting of planes of mutually different angles are juxtaposed at a predetermined pitch.

One important feature of Claim 1 is that the dividing element is comprised of repetitions of such structure that a plurality of V-shaped grooves consisting of planes of mutually different angles are juxtaposed. This feature of the invention, as recited in Claim 1, enables the light beam to be divided into four directions.

Igaki et al. relates to an apparatus for measuring displacement information. Igaki et al. teaches moving a position of incidence of a luminous flux from a light-projected means to an optical scale and adjusting an output signal from a plurality of photo detecting elements to obtain accurate displacement information. Igaki et al. neither teaches nor suggests providing V-shaped grooves having different angled slopes by which four beams can be directed toward the light-receiving elements (Figure 12A and 12B), rather Igaki et al. discloses only three directions. Further, the present invention is an improvement of Igaki et al. as noted in the Background of the Invention and Summary of the Invention sections of the present invention, by providing an optical encoder capable of always generating stable pulses without variation in the width and phase even if the amount of light varies. Accordingly, Applicants submit that Claim 1 is not anticipated by Igaki et al. taken alone.

Igaki relates to an optical encoder employing an optical scale for measurement of displacement. Igaki teaches an encoder provided with a light emitting device for emitting irradiating light. The encoder includes a first scale on which a substantially light transmitting portion and light shielding portion are periodically provided, a second scale which is adapted to be displaced relative to the first scale and on which V-shaped groove and light transmission plane portions are periodically

provided at a first surface facing the first scale. The encoder also includes a light receiving device arranged to face a second surface of the second scale for receiving light having passed through the first and second scales, and a detecting device for detecting the relative displacement of the two scales based on the output signals from the light receiving device. Igaki neither teaches nor suggests a dividing element comprised of repetitions of such structure that a plurality of V-shaped grooves consisting of planes of mutually different angles are juxtaposed. Figure 11 of the present invention depicts the dividing element in which the V-shaped grooves consist of slopes with two different angles $\theta 1$ and $\theta 2$. In contrast, Igaki in Figure 3B depicts the movable scale in which the V-shaped grooves consist of slopes with one angle, θ.

Applicants submit that a combination of Igaki et al. and Igaki, assuming such combination would even be permissible, would fail to teach or suggest a dividing element comprised of repetitions of such structure that a plurality of V-shaped grooves consisting of planes of mutually different angles are juxtaposed.

Accordingly, Applicants submit that Claim 1 is patentable over the cited art, and respectfully request withdrawal of the rejection under 35 U.S.C. § 103(a).

Independent Claim 30 includes the same feature of a dividing element comprised of repetitions of such structure that a plurality of V-shaped grooves consisting of planes of mutually different angles are juxtaposed, as discussed above in connection with Claim 1. Accordingly, Claim 30 is believed to be patentable for at least the same reasons as discussed above in connection with Claim 1.

One important feature of Claim 13 is that in the optical scale the scale slits of the first

and second region are comprised of grooves of V-shaped cross section and the slope angles are different from each other between the grooves of the V-shaped cross section of the scale slits in the first and second regions.

The Office Action correctly states that the cited prior art does not teach or disclose the features of Claim 13. However, Applicants respectfully traverse the Examiner's assertion that a rearrangement of sizes is generally recognized as being within the level of ordinary skill in the art. Please note that Claim 13 corresponds to the fifth embodiment shown in Figure 21A and 21B, for example, in which the V-shaped groove in the first region has a slope angle $\theta 1$ and the V-shaped groove in the second region has a slope angle $\theta 2$ which is different from slope angle $\theta 1$. Accordingly, the radius of curvature of the concave mirror is set to a predetermined value, so that the encoder can be set using the same detection head while maintaining the diameter of the optical scale. As long as the purpose of the feature is not recognized, Applicants assert that it would not have been obvious, to one having ordinary skill in the art, to have the slope angles different from each other between the grooves of the V-shaped cross section of the scale slits in the first and second regions.

Accordingly, Applicants submit that Claim 13 is patentable over the cited art, and respectfully request withdrawal of the rejection under 35 U.S.C. § 103(a).

Independent Claim 33 includes the same feature that in the optical scale the scale slits of the first and second region of the optical scale are comprised of grooves of V-shaped cross section and the slope angles are different from each other between the grooves of the V-shaped cross section of the scale slits in the first and second regions, as discussed above in connection with Claim 1. Accordingly, Claim 33 is believed to be patentable for at least the same reasons as discussed above in

connection with Claim 13.

One important feature of Claim 16 is the V-shaped grooves of the scale slits in the second region comprises slopes of N types of angles in one period. Accordingly, the number of divisions of light beams can be increased, whereby the S/N ratio of the signal can be enhanced by taking the in amplitude.

The Office Action correctly states that the cited prior art does not teach or disclose the features of Claim 16. Applicants respectfully traverse the Examiner's assertion that it would have been obvious, to one having ordinary skill in the art at the time the invention was made, to have the V-shaped grooves comprising slopes of N types of angles in one period. Unless the purpose of the feature is recognized, it would not have been obvious to one having ordinary skill in the art to incorporate V-shaped grooves of the scale slits in the second region comprising slopes of N types of angles in one period.

Accordingly, Applicants submit that Claim 16 is patentable over the cited art, and respectfully request withdrawal of the rejection under 35 U.S.C. § 103(a).

Independent Claim 34 includes the same feature of V-shaped grooves of the scale slits in the second region comprising slopes of N types of angles in one period, as discussed above in connection with Claim 16. Accordingly, Claim 34 is believed to be patentable for at least the same reasons as discussed above in connection with Claim 16.

One important feature of Claim 18 is that the light traveling from the light irradiating system to the scale slits of a first region of the optical scale is reflected by the first region and condensed via only one condensing mirror onto the scale slits of a second region of the optical scale and reflected

by the second region as to be guided to the light-receiving element.

Applicants fail to find any teaching or suggestion in the prior art that light from an irradiating system is reflected twice by the optical scale to be directed to the light-receiving element.

Accordingly, Applicants submit that Claim 18 is patentable over the cited art, and respectfully request withdrawal of the rejection under 35 U.S.C. § 103(a).

Independent Claim 35 includes the same feature of light traveling from the light irradiating system to the scale slits of a first region of the optical scale is reflected by the first region and condensed via only one condensing mirror onto the scale slits of a second region of the optical scale and reflected by the second region as to be guided to the light-receiving element, as discussed above in connection with Claim 18. Accordingly, Claim 35 is believed to be patentable for at least the same reasons as discussed above in connection with Claim 18.

The other claims in this application depend from one or another of the independent claims discussed above, and, therefore, are submitted to be patentable for at least the same reasons. Since each dependent claim is also deemed to define an additional aspect of the invention, individual reconsideration of the patentability of each claim on its own merits is respectfully requested.

In view of the foregoing amendments and remarks, Applicants respectfully request favorable reconsideration and early passage to issue of the present application.

Applicants' undersigned attorney may be reached in our New York Office by telephone at (212) 218-2100. All correspondence should continue to be directed to our address listed below.

Respectfully submitted,

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MARKED-UP VERSION SHOWING CHANGES MADE TO SPECIFICATION

The paragraph starting at page 25, line 16 has been amended as follows.

In the case of the conventional example, since the angles of the V-grooves of the second region 13b and the first region 13a are equal, angles of refraction are large as illustrated in Figs. 5A to 5C, and the lens size on the light reception side and the spacing between the light-receiving elements 6 are also large, thereby increasing the dimensions of the detection head as a result. On the other hand, for example, when the angles of the V-grooves of the second region 13b are smaller than those of the first region 13a as in the present embodiment, the angles of refraction in the second region 13b become smaller as illustrated in Fig. 22A, whereby the size of the lens 12 and the spacing between the light-receiving elements [15] <u>15a, 15b, 15c</u> can be made smaller as illustrated in Fig. 22B, thereby making the detection head compact.

The paragraph starting at page 37, line 9 has been amended as follows.

The optical encoders described above are constructed so that all the components are placed on one side of the optical scale, and thus the axial height is small. Since the optical encoders obviate the need for a fixing arm for fixing the parts on the opposite side of the optical scale on the theoretical basis, there is no portion projecting to the outside from the outside periphery of the optical scale <u>D</u> and this decreases the total size and the number of components. The displacement information can be detected with good contrast by the compact

MARKED-UP VERSION SHOWING CHANGES MADE TO CLAIMS

16. (Amended) An optical encoder comprising:

light irradiating system;

an optical scale comprising scale slits of a periodic structure;

a light-receiving element; and

an optical system constructed so as to make light traveling from said light irradiating system to the scale slits of a first region of said optical scale, incident to the scale slits of a second region of said optical scale by a mirror or another optical element to guide the light having passed via the scale slits of the second region to said light-receiving element;

wherein in said optical scale the scale slits of said first and second regions are comprised of grooves of V-shaped cross section and wherein the [V-shape of the] <u>V-shaped</u> grooves of the scale slits in said second region comprises slopes of N types of angles [in a number of P/N] in one period <u>and each slope has a width of P/2N,</u> where P is a pitch of the periodic structure of the scale slits and N a natural number.

18. (Amended) An optical encoder comprising:

light irradiating system;

an optical scale comprising scale slits of a periodic structure;

a light-receiving element; and

an optical system constructed so that light traveling from said light irradiating system to the scale slits of a first region of said optical scale and reflected by the first region is [reflected and] condensed via only one condensing mirror onto the scale slits of a second region of said optical scale and is reflected by the second region so [that the light having passed via the scale slits of the second region is] as to be guided to said light-receiving element.

34. (Amended) A driving system comprising:

a driver system;

a control system for controlling driving of said driver system; and

an optical encoder for detecting information on the driving of said driver system to output a signal to said control system, said optical encoder comprising:

(1) light irradiating system;

(2) an optical scale comprising scale slits of a periodic structure;

(3) a light-receiving element; and

(4) an optical system constructed so as to make light traveling from said light irradiating system to the scale slits of a first region of said optical scale, incident to the scale slits of a second region of said optical scale by a mirror or another optical element to guide the light having passed via the scale slits of the second region to said light-receiving element;

wherein in said optical scale the scale slits of said first and second regions are comprised of grooves of V-shaped cross section and wherein the [V-shape of the] V-shaped

grooves of the scale slits in said second region comprises slopes of N types of angles [in a number of P/N] in one period and each slope has a width of P/2N, where P is a pitch of the periodic structure of the scale slits and N a natural number.